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Sustainable freight transport in support of the 2030 Agenda for Sustainable Development

Note by the UNCTAD secretariat

Executive summary

The fifth session of the Multi-year Expert Meeting on Transport, Trade Logistics and Trade Facilitation considered the linkages between trade logistics and the 2030 Agenda for Sustainable Development, and discussed how best to leverage the sustainable freight transport dividend to enable effective implementation of the 2030 Agenda, the Sustainable Development Goals and the Paris Agreement under the United Nations Framework Convention on Climate Change. The sixth session will investigate in greater detail how freight transport can contribute to sustainable development.

The role of maritime transport in achieving a sustainable development path is addressed in this note. With over 80 per cent of world merchandise trade carried by sea and with shipping and ports forming an integral part of any door-to-door transport solution, the strategic importance of maritime transport and its potential to support more sustainable economies and societies cannot be overemphasized. The note provides an overview of relevant issues at the interface of sustainable development and maritime transport; highlights how the sustainability of maritime transport can support the effective achievement of the 2030 Agenda and the Goals, as well as the Paris Agreement; and presents some trends in digital solutions and innovations that entail transformational effects in all sectors, including maritime transport. The Multi-year Expert Meeting provides an opportunity to discuss the potential of digital technologies to support the maritime transport sustainability agenda.

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I. Introduction and background

1. The 2030 Agenda and the Sustainable Development Goals, as well as the Paris Agreement, have reinforced the commitment of the international community to achieving a sustainable development path. Together, they underscore the importance of mainstreaming sustainability principles and climate action criteria into all economic activities and sectors, including freight transport.

2. The fifth session of the Multi-year Expert Meeting considered the linkages between trade logistics and the 2030 Agenda, and discussed how best to leverage the sustainable freight transport dividend to enable effective implementation of the 2030 Agenda, the Goals and the Paris Agreement. The 2030 Agenda does not include a dedicated goal on transport, yet the strategic importance of the sector as a cross-cutting factor that can enable the realization of various Goals is widely recognized. Transport is integrated in various Goals and targets and has gained greater visibility under the climate action agenda of the United Nations Framework Convention on Climate Change; a number of nationally determined contributions, which reflect the efforts of countries to reduce national greenhouse gas emissions and adapt to the impacts of climate change, increasingly refer to transport.[1]

3. The nexus between the 2030 Agenda, the Goals, the Paris Agreement and sustainable freight transport is strong. Freight transport is linked to wide-ranging aspects of modern societies and economic structures. It adds value to the economy and generates social gains, including by supporting trade, linking supply chains, enhancing connectivity, allowing for market access, generating employment and enabling business opportunities. However, such benefits may be eroded if unsustainable freight transport practices continue in business-as-usual patterns. Adopting a triple bottom-line view, which promotes balanced trade-offs that ensure optimum economic and social gains with minimum environmental damage, is key to resolving the growth and sustainability dilemma and supporting the achievement of the Goals.

4. UNCTAD has long recognized the linkages between sustainable development and trade logistics, including in the context of relevant global processes and policy frameworks, which include, among others, resolution 69/213 of the General Assembly on the role of transport and transit corridors in ensuring international cooperation for sustainable development; the Second United Nations Conference on the Landlocked Developing Countries; the third International Conference on Small Island Developing States; the Global Conference on Sustainable Transport held in 2016; and the latest three sessions of the Conference of the Parties to the United Nations Framework Convention on Climate Change.

5. In recent years, UNCTAD has focused on promoting the integrated treatment of the economic, social and environmental dimensions of transport, as reflected in the Accra Accord, the Doha Mandate and the Nairobi Maafikiano.[2] UNCTAD is also actively involved in multi-stakeholder collaborative efforts such as the Sustainable Mobility For All initiative, which brings together various transport stakeholders from the public and private sector committed to advancing equitable, safe, efficient and green transportation worldwide.[3]

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[1] See www.ppmc-transport.org/overview_indcs.
Note: All websites referred to in footnotes were accessed in September 2018.

[2] Among other outcomes, the Accra Accord emphasized the need to promote inclusive growth that would help countries attain and sustain internationally agreed development goals and the Doha Mandate emphasized the need to focus not only on creating sustained economic growth, but also on broadening the basis of growth and making it more inclusive. The Nairobi Maafikiano refers to transport and trade facilitation in paragraphs 10 and12; 38 (j), (k), (p), (s), (x) and (z); 55 (b), (f–l), (x), (aa) and (gg); 76 (d), (e), (s) and (t); and 100 (d) and (t).

[3] See https://sum4all.org/sustainable-mobility-all.

6. This note addresses the role of maritime transport (a backbone of international trade and globalization) in achieving a sustainable development path. Addressing sustainability in maritime transport is both topical and timely, in particular given the adoption under the auspices of the International Maritime Organization (IMO), in April 2018, of an initial strategy on the reduction of greenhouse gas emissions from ships, which represents the first global climate framework for shipping. With over 80 per cent of world merchandise trade carried by sea and with shipping and ports forming an integral part of any door-to-door transport solution, the strategic importance of maritime transport and its potential to support more sustainable economies and societies cannot be overemphasized. It is an economic sector in its own right and an enabler of other activities such as trade, globalized production processes, fisheries and maritime tourism.

7. The concept of sustainable transport may entail varied definitions and promote a specific dimension such as the economy (efficient and competitive transport), society (inclusive transport) or the environment (green transport). UNCTAD has noted that sustainable maritime transport involves balancing all three dimensions in the sector. Specifically, it involves, among other criteria, maritime transport infrastructure, services and operations that are efficient, safe, socially acceptable, universally accessible, reliable, affordable, fuel-efficient, environmentally friendly, low-carbon and climate change-resilient.

8. Recent accelerated growth in technological advances and innovations suggest a significant potential for such technologies to support sustainability-building efforts in maritime transport. Technologies and digital solutions of particular relevance to maritime transport involve parameters such as location, the connection of devices, big data analytics, cognitive computing and open platforms for data and information capture, processing and access, as well as networks and data environments. Their application could permeate all aspects of transport, including operations, planning, infrastructure design, development and maintenance. They bring new opportunities by unlocking value that extends beyond traditional activities such as transporting or handling cargo. However, many questions remain given the uncertainty and, in some cases, risks and vulnerabilities that may be associated with various emerging digital solutions and innovations. Such innovations need to evolve and mature to ensure their wide acceptance, affordability, reliability and safety, in order to support maritime transport sustainability objectives. Monitoring relevant developments is therefore important.

9. Bearing in mind such considerations, this note provides an overview of relevant issues at the interface of sustainable development and maritime transport; highlights how the sustainability of maritime transport can support the effective implementation of the 2030 Agenda and the Goals, as well as the Paris Agreement; and presents some trends in digital solutions and innovations that entail transformational effects in all sectors, including maritime transport. The Multi-year Expert Meeting provides an opportunity to discuss recent developments related to sustainability in maritime transport, examples of recent work by UNCTAD in the field of sustainability-building in freight transport and the opportunities and challenges that may be associated with new technological developments.

II. Key trends shaping the sustainability agenda in maritime transport

10. The ability of the maritime transport sector to deliver on the sustainability imperative is influenced by various developments. This chapter provides an overview of some relevant trends shaping the maritime transport sustainability landscape and is not exhaustive but, rather, indicative of some of the most pressing and persistent concerns and priorities in maritime transport.

A. Economic growth and transport activity

11. Demand for maritime transport is a derived demand that moves in tandem with the growing world population, consumption needs, industrial activity, urbanization, trade and

economic growth. In a baseline scenario, the Organization for Economic Cooperation and Development projects that total freight transport demand, both domestic and international, measured in billions of ton-kilometres, will triple in 2015–2050, primarily driven by economic growth.[4] UNCTAD estimates world seaborne trade volumes to have increased by 3.8 per cent in 2017, taking the total to 10.7 billion tons, and these volumes are projected to expand at a compound annual growth rate of 3.8 per cent between 2018 and 2023.[5] At this rate, world seaborne trade volumes can be expected to double in about two decades. These trends, together with a business-as-usual approach to maritime transport that does not take into account relevant sustainability objectives, can undermine the ability of the sector to deliver on sustainability plans and objectives and the 2030 Agenda.

B. Energy consumption

12. Increased activity entails greater energy consumption, and energy demand from international shipping increased at an annual rate of 1.6 per cent in 2000–2014.[6] In 2012, shipping used an estimated 300 million tons of bunker fuel per year, with international shipping accounting for 86 per cent of this total.[7] Energy consumption and a heavy reliance on oil for propulsion systems challenges the sustainability of the sector. Marine bunker fuels have a high carbon intensity and are highly polluting. At the same time, the sector is not yet in a position to fully switch to alternative fuels or widely use energy efficiency technologies. Projections for 2040 indicate that over half the increase in energy use in freight transport is likely to be generated by shipping.[8]

C. Infrastructure gaps, access and connectivity

13. Inadequate and poor conditions of maritime transport infrastructure, as well as limited and constrained physical access to ports and inadequate hinterland connections, can undermine the sector's role as a driver of trade, global economic integration and sustainable development. Such conditions raise costs, extend delays, reduce reliability and undermine shipping connectivity. Limiting the shipping connectivity of countries, in particular small island developing States, calls into question the sustainability of the sector.

D. Mega ships and capacity constraints

14. The deployment of mega ships over the past few years has affected port terminals across the ship–port interface, yard and terminal activities and gate and hinterland operations. The physical features and handling requirements of such ships add pressure to port operations and infrastructure. Enhancing port efficiency and productivity is becoming increasingly important, to reduce costs and enhance trade competitiveness. Port sustainability objectives are increasingly being defined by such additional pressures, and port operators and administrators, as well as other port community stakeholders, need to improve performance with regard to the economic, social and environmental dimensions of sustainability.

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[4] Organization for Economic Cooperation and Development, 2017, *[International Transport Forum] Transport Outlook 2017*, Paris.

[5] UNCTAD, 2018, *Review of Maritime Transport 2018*, United Nations publication, Sales No. E.18.II.D.5, New York and Geneva.

[6] IMO, 2014, *Third IMO Greenhouse Gas Study 2014*, London.

[7] Ibid.

[8] United States of America, Energy Information Administration, 2017, *International Energy Outlook 2017*, Washington, D.C.

E. Transport costs

15. Sustainable maritime transport entails affordable and reasonably priced shipping and port services that, at the same time, generate value for service providers. This requires effective control over the factors influencing maritime transport costs, including infrastructure, trade (volumes, economies of scale and directional imbalances), competition, type of products shipped and position in relevant shipping networks (centre and/or periphery, hub and/or feeder ports and services). Greater sustainability in maritime transport therefore requires, as a matter of priority, the determinants of maritime transport costs to be better understood and the overreliance of the sector on oil-based propulsion systems to be effectively reduced.

F. Air pollution

16. The emission of air pollutants from maritime transport, including sulphur oxide and nitrogen oxide emissions, constitute a major setback to the sustainability of the sector. Such emissions pose health and public safety hazards. International ship emissions of sulphur oxide and nitrogen oxide in 2007–2012 were an estimated 12 and 13 per cent of total global emissions of such pollutants, respectively.[9] Air pollution from shipping is regulated by IMO through the International Convention for the Prevention of Pollution from Ships, 1973/1978. The shipping industry is currently considering how best to comply with evolving requirements under IMO related to emissions, including switching to alternative fuels with lower sulphur content (marine distillates), installing scrubber systems and using liquefied natural gas. Energy efficiency is important for oil security and a reduced reliance on fossil fuels and it is also important to reduce harmful air pollutants. Key regulatory measures promoting energy efficiency in maritime transport, under IMO, are the energy efficiency design index, energy efficiency operational indicator and ship energy efficiency management plan, in force since 2013.[10] By addressing energy efficiency, these regulations help achieve the objectives of both reducing maritime transport energy intensity and dependence and of reducing emissions. In this context, developing and implementing energy efficient shipping systems remains a priority.

G. Greenhouse gas emissions

17. Carbon dioxide emissions from marine bunkers expanded rapidly in 1990–2015, at a rate of 77 per cent, which was faster than the rate for road transport. Total shipping emissions reached approximately 938 million tons of carbon dioxide in 2012, and international shipping emissions accounted for 85 per cent of this total, with 796 million tons of carbon dioxide, or approximately 2.2 per cent of total global carbon dioxide.[11] In comparison with other modes, shipping remains an efficient mode of transport in terms of carbon dioxide emissions per ton-mile. However, without mitigating actions, carbon emissions from the sector can be expected to increase and create important sustainability challenges. Forecast scenarios for the medium term suggest that international carbon emissions could increase by 50–250 per cent by 2050, depending on economic growth and global energy demand.[12] Shipping therefore has a key role in helping to achieve the internationally agreed goal in the Paris Agreement of limiting the global average temperature increase to below 2°C above pre-industrial levels. A number of nationally determined contributions under the United Nations Framework Convention on Climate Change framework propose mitigation measures in transport, yet remain insufficient. Carbon dioxide emissions from freight transport, including maritime transport, are noted in only 29 per cent of nationally determined contributions submitted as at 1 August 2016, a

[9] IMO, 2014.

[10] IMO, 2017, Consideration of how to progress [in] the matter of reduction of [greenhouse gas] emissions from ships, ISWG-GHG 1/2, London, 21 February.

[11] Ibid.

[12] Ibid.

share incommensurate with the 40 per cent share of the sector in global carbon dioxide emissions.[13] Trade-related international freight volumes are expected to grow by a factor of 4.3 in 2050, compared with 2010, and world road and rail freight volumes are expected to increase by more than threefold and over fivefold, respectively, by 2050.[14] One third of trade in 2050 will occur among developing economies, compared with 15 per cent in 2010.[15] The freight transport sector will be increasingly expected to be economically efficient and at the same time achieve greater energy efficiency, resilience, social inclusiveness and resource conservation and to minimize negative environmental impacts.

18. The Kyoto Protocol delegated to IMO work on limiting or reducing greenhouse gas emissions from marine bunker fuels.[16] In 2016, IMO adopted a mandatory data collection system for fuel consumption by ships and a road map for developing a comprehensive IMO strategy on the reduction of greenhouse gas emissions from ships. In April 2018, IMO adopted an initial strategy on this matter, which aims at the reduction of total annual greenhouse gas emissions from ships by at least 50 per cent by 2050, compared with 2008, and includes quantitative reduction targets through 2050, with short-term, midterm and long-term policy measures to help achieve the targets.[17] In addition, the strategy aims to phase out emissions entirely.[18] Discussions on market-based measures, under the auspices of IMO and the United Nations Framework Convention on Climate Change framework, are ongoing, including such measures as levies or taxes and emissions-trading mechanisms, yet an agreement on this issue has not yet been reached. Under the initial strategy, market-based measures may be potential midterm measures, to be agreed upon in 2023–2030. Various considerations need to be addressed, including the potential implications of market-based measures for transport costs and trade competitiveness, in particular in developing countries, including small island developing States and landlocked developing countries.

III. Enabling the sustainability of maritime transport

A. Land-based transport corridors and island shipping

19. The transition to sustainable maritime transport systems may be challenging, in particular in developing countries. A key obstacle to sustainable maritime transport is a limited understanding of how the economic, social and environmental dimensions of sustainability can be mutually reinforcing when integrated into relevant transport planning, investment and policymaking processes. Other barriers include the lack of global standards for sustainable performance measurements, limited access to technologies, insufficient global coordination, inadequate and insufficient access to financing, a lack of investment, infrastructure gaps and poor infrastructure maintenance, as well as weak supportive national policies and legal and regulatory frameworks. In some instances, in particular in small island developing States and landlocked developing countries, additional constraints apply, given State size, geography and vulnerability to shocks, including environmental shocks.

20. In this context, in accordance with its mandate, UNCTAD has in recent years assisted developing countries to build knowledge and capacity to plan, design and implement effective solutions and measures that enable sustainable freight and maritime transport. UNCTAD has carried out sustainability-minded work in the field of maritime transport by focusing on the economic aspects of sustainability, including by assisting

[13] See www.ppmc-transport.org/overview_indcs.

[14] Organization for Economic Cooperation and Development, 2015, *[International Transport Forum] Transport Outlook 2015*. Paris.

[15] Ibid.

[16] See http://unfccc.int/methods/emissions_from_intl_transport/items/1057.php.

[17] IMO, 2018, Report of the Working Group on Reduction of Greenhouse Gas Emissions from Ships. MEPC 72/WP.7, London, 12 April.

[18] See www.imo.org/en/mediacentre/pressbriefings/pages/06ghginitialstrategy.aspx.

developing countries to better integrate into the world economy. UNCTAD is increasingly aligning its work with several targets under the Goals and emphasizing not only economic considerations of sustainable freight transport, but also the environmental and social dimensions.

21. UNCTAD advocates sustainable and resilient shipping and ports and the need to generally promote blue growth. In addition, attention is given to port hinterland connections, in particular in the context of transit transport corridors.[19] Such work is carried out while building on synergies and complementarity with the work of other stakeholders, including Governments and industry. Various measures have been adopted over the years at the national, regional and international levels, as well as at the industry level through voluntary self-regulation by shipping and ports. Self-regulation allows for greater participation by all stakeholders along with some flexibility through the choice of approaches and solutions adopted, including, among others, technology-based and innovative solutions, such as electronic devices for monitoring engines; fuel-related measures, such as cleaner fuels; economic measures, such as congestion pricing; strategic and operational measures, such as slow steaming; regulatory measures, such as emission standards; and other approaches such as training.

22. Such approaches may be seen in UNCTAD technical assistance aimed at assisting countries to build capacity to promote and implement sustainable freight transport solutions. For example, a project under the United Nations Development Account entitled "Building capacities of developing countries to shift towards sustainable freight transport" aims to strengthen the capacity of policymakers, transport operators and key financial institutions in Africa and in small island developing States in the Caribbean to promote and finance sustainable freight transport through sound transport policy measures and adequate financing actions and mechanisms.[20] A number of capacity-building tools and instruments have been developed under the project and made available to developing countries, to help build capacity and to advise on sustainable transport policymaking processes (box 1).

Box 1
UNCTAD sustainable freight transport tools and instruments

UNCTAD support on sustainable freight transport systems is underpinned by insights generated through relevant research and analytical work, as well as policy guidance derived from consensus-building activities and practical lessons gained from interventions in the field. Key instruments and tools developed by UNCTAD to support a shift towards sustainable freight transport systems are featured in the UNCTAD sustainable transport and finance toolkit and include a methodology to assess gaps and strengthen capacity to design, develop and implement sustainable transport and finance strategies; a training and capacity-building package, including case studies, good practices and resources; and an online portal facilitating information-sharing and partnership-building.

All three components are flexible, as they allow for tailored solutions that respond to local conditions and the specific needs of users. The flexibility embedded in the tools makes it possible to set priorities and objectives while bearing in mind the specific requirements and needs of the varied beneficiaries.

Source: UNCTAD, 2018, Sustainable freight transport and finance toolkit, available at http://unctad.org/en/Pages/DTL/TTL/Infrastructure-and-Services/SFTF-Toolkit.aspx. Also see https://unctadsftportal.org.

23. UNCTAD has carried out various activities to help raise awareness among beneficiary countries, improve their understanding and develop tailored strategies to implement sustainable transport principles, whether at the national, regional, subregional, corridor or company level, as well as in urban and rural transport contexts. For example,

[19] See http://unctad.org/en/Pages/DTL/TTL/Infrastructure-and-Services/Transport-Networks-and-Corridors.aspx.

[20] See www.un.org/esa/devaccount/projects/2014/1415Q.html.

this has allowed the Central Corridor Transit Transport Facilitation Agency and the Northern Corridor Transit and Transport Coordination Authority to commit to promoting sustainable freight transport strategies in the respective corridors. Collaboration with the Agency and Authority has culminated in various milestones, including defining the sustainable freight transport objectives, goals and visions of each corridor; identifying key challenges undermining their sustainability; and mapping out specific, tailored solutions to respond to the identified challenges. Relevant work has helped the Agency and Authority and the respective member States to articulate draft sustainable freight transport strategies and related action plans, which will be integrated into the five-year strategic plans of the Agency and Authority. In the Northern Corridor, the commitment to promote sustainable freight transport strategies has translated into the development of a green freight programme in collaboration with UNCTAD and the United Nations Environment Programme. This is the first element of a multipronged and longer term sustainable freight transport strategy planned by the Authority.

24. UNCTAD assists small island developing States to build capacity to design, develop and implement sustainable freight transport solutions. UNCTAD focuses on shipping and ports, in view of the unique geographical landscape in these States and overreliance on maritime transport for trade. As part of the project under the United Nations Development Account, UNCTAD has delivered a tailored regional capacity-building workshop in Barbados focused on sustainable freight transport and finance in the Caribbean. Participants included representatives from the public and private sectors of 10 member States of the Caribbean Community, namely Antigua and Barbuda, Bahamas, Barbados, Grenada, Guyana, Jamaica, Saint Kitts and Nevis, Saint Lucia, Saint Vincent and the Grenadines and Trinidad and Tobago. This work helped identify, in close consultation with local stakeholders, data needs and requirements; persistent sustainability challenges, such as the prohibitive transport costs in the region; and training requirements, such as in ecodriving, which aims to improve economical, ecological and safe truck driving. UNCTAD is providing support to the region in articulating a sustainable freight transport strategy, in collaboration with the Caribbean Development Bank. The strategy will address all modes of transport, focusing in particular on maritime transport issues, such as regional connectivity, inter-island shipping and the establishment of a data observatory.

B. Technological advances and innovation

1. Relevant digital solutions and innovations

25. The concept of the fourth industrial revolution, or industry 4.0, is associated with various fields and technologies such as machine learning and data science, which permit increasingly autonomous and intelligent systems; low-cost sensors, which in part underpin the Internet of things; and control devices that make second-generation industrial robotics possible.[21] It is also closely associated with digitalization, which involves the digitization of data and information, that is, moving away from manual processes to automated workflows and processes; and describes a deeper digitally-enabled transformation of interactions, communications, business functions and models. The digital revolution entails some important implications for all sectors, including maritime transport. Emerging innovations of relevance to the sector include, inter alia, artificial intelligence, blockchain technology, the Internet of things and automation, all of which have the potential to increase efficiency and reduce costs, among other benefits.

26. Adopting such technologies is not straightforward, and a number of risks, threats, uncertainties and prerequisites make wide adoption and application difficult. First, relevant regulatory and legal frameworks need to be updated and made fit for purpose, to address the risks and challenges that may arise from applying new technology. Potential concerns include, for example, how to assign liability for decisions resulting from a reliance on erroneous data and other concerns related to privacy, consumer protection, competition and

[21] Organization for Economic Cooperation and Development, 2018, *The Next Production Revolution Implications for Governments and Business*, Paris.

taxation.[22] Second, various distributed ledger technologies, including blockchain, are emerging and proliferating at a rapid pace, leading to concern over the potential emergence of one solution as the dominant standard for the industry, and related issues of interoperability and standardization.[23] Some of the new technologies could generate greater consolidation and concentration, as they lead to more interconnected business processes and horizontal integration. They tend to exclude smaller operators from the market, who might have limited capacity to invest in and access big data intelligence. Third, technological advances such as autonomous ships and drones entail safety and security risks. Increased interconnections between control, electric and power systems and their connection over the Internet have increased the probability of cyberattacks, such as to damage cargo or interfere with crane load instructions, ballast water issues, the labelling of dangerous chemicals and the defrosting of reefers. Finally, there are implications for the labour market. Understanding sectoral trends is key to identifying the possible required skills and adapting training to ensure that the maritime labour force is well prepared. In developing countries, digital innovations could raise concerns over the fact that reduced access to technologically enabled infrastructure may lead to reduced maritime transport connectivity through reduced services and operators.

27. Applying digital solutions and technologies in maritime transport is therefore a work in progress and will continue to evolve as relevant technologies are tested, verified and trusted and become affordable and as their potential negative impacts and likely safety and security risks are effectively addressed.

2. Sustainability-building potential of selected technological innovations

28. Blockchain technology and the Internet of things are currently being considered by the maritime transport industry, as they can help optimize operations and improve processes through data analytics. The aim is to reduce costs, enhance efficiencies and profitability and provide solution-oriented value-added services that meet consumer demands for increased traceability and reliability. Such technologies lead to new business models and redefining processes within and between companies. They also increase connectivity between different actors and activities across the maritime supply chain and between maritime supply chains and broader logistics and supply chain interfaces.

29. Some such digital technologies make shipping companies, in particular container ship operators, more aware of the benefits of becoming global logistics chain experts, inducing a move from the core business to logistics integrators through the use of information technology platforms. This also presents opportunities for enhanced multimodal connections, particularly between ships, automated terminals and vehicles that carry cargo to and from hinterlands. In addition, digital technologies influence competition in the sector. Companies compete based on electronic commerce strategies, developing value-added digital services based on information technology portals and applications, enabling greater control by cargo owners, instead of a reliance on vessel owners and intermediaries. This digital advancement entails significant investment in technological development. Of the 94 companies identified as being at the forefront of transforming container shipping through technology, from 2014 to 21 January 2018, 34 companies received total funding of $866 million.[24] Investing in the adoption of big data and cloud computing technologies for the maritime industry can be worth up to $792 million.[25]

30. In view of the significant efficiency gains and potential for generating greater value, the rapidly increasing digital innovations may have a role in building the sustainability of the maritime transport sector. The table identifies four areas in which technology could contribute to building such sustainability by helping to reduce carbon emissions.

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[22] Ibid.

[23] UNCTAD, 2018.

[24] World Maritime News, 2018, SeaIntel: Maritime technology investments nearing $1 billion, 25 January, available at https://worldmaritimenews.com/archives/241747/seaintel-maritime-technology-investments-nearing-usd-1-bn/.

[25] Fairplay, 2018, [China Ocean Shipping (Group) Company] fund to invest in technology, 26 February.

Technologies that can help reduce carbon dioxide emissions in the maritime sector

Improvement level	*Examples of technologies in use*
Level 1: Vessels and loading	Software using satellite-generated data to determine the most efficient route, including weather routing, which takes into account currents and weather forecasts as well as real-time sea conditions, to determine the most fuel-efficient route for long-distance voyages.
	Intelligent containers, with sensors and telematics to track temperature, vibration, humidity and air quality during transport.
Level 2: Organization or company	Predictive logistics approaches, such as algorithms, with the potential to assist in predicting customer behaviour, operational performance and market movements, based on previous transactions. This could enable carriers, forwarders, shippers and terminals to make asset-allocation decisions based on more accurate estimations and thereby improve operational and commercial efficiency, which could help avoid empty legs and higher load factors, and thus reduce fuel consumption.
	Information technology-based tools to measure economic and environmental efficiency and compare it anonymously to peers, enabling conclusions to be drawn for the improvement of business practices and investment decisions, for example as offered for ports through the Portopia platform.
Level 3: Supply chain	Inter-organization systems for customer and supplier relationship management, which provide a way to manage business activities between two organizations, such as sales, marketing and customer services (customer relationship management) and procurement and distribution (supplier relationship management).
Level 4: Multiple supply chains (network systems with participants and communications simultaneously conducted between two or more companies)	Routing, resource planning and scheduling based on real-time tracking and telematics data, which allows for the integration of maritime and hinterland transport in the framework of port community systems.
	Open and closed electronic logistics marketplaces involving shippers, carriers and customers, to enable horizontal transport collaboration between shippers or carriers (shared logistics capabilities).

Sources: International Council on Clean Transportation, 2011, Reducing greenhouse gas emissions from ships: Cost effectiveness of available options, White paper No. 11, July; Lloyd's List Intelligence, 2016, Get smart for a clear view of logistics, November; UNCTAD, 2018; Y Wang, VS Rodrigues and L Evans, 2015, The use of [information and communications technology] in road freight transport for [carbon dioxide] reduction: An exploratory study of [the United Kingdom of Great Britain and Northern Ireland] grocery retail industry, *The International Journal of Logistics Management*, 26(1):2–29; and World Economic Forum, 2016, Digital transformation of industries: Logistics industry, White paper.

31. New technologies, such as blockchain technology and the Internet of things, are of particular interest for maritime transport, while existing concepts such as port community systems are being revisited in the light of the latest developments related to open online collaboration platforms and their relevance to single windows. The following sections provide an overview of some considerations related to such technologies.

a) Blockchain

32. Blockchain is a distributed ledger technology that enables peer-to-peer transactions that are securely recorded, as in a ledger, in multiple locations at once and across multiple organizations and individuals, without the need for a central administration or intermediaries.[26] There are several types of blockchain technology and many applications. The technology includes the following main features:[27]

(a) Transparent: Recordings are made of all exchanges between users;

(b) Secure: Each transaction is encrypted and digitally signed to ensure its authenticity and integrity;

(c) Immutable: Once a block is written to a blockchain, it cannot be altered;

(d) Distributed: Transactions are shared and verified by different users, without requiring an intermediary to verify the validity of events.

33. Blockchain technology can help improve communications and collaboration and increase information and data-sharing in maritime supply chains. For example, different varieties of maritime single windows are being developed to handle a quotation encompassing an entire ocean transport transaction, including booking, documentation generation and customs clearance.

34. Several initiatives that focus on the container shipping segment have emerged, although blockchain is not yet fully implemented across the sector. For example, Maersk and International Business Machines (IBM) intend to establish a joint venture with the aim of developing an open trade-digitalization platform, designed for use by the entire industry, to help companies move and track goods digitally across international borders, to improve global trade and digitize supply chains.[28] Another initiative involves a blockchain platform that can eliminate the need for printed shipping documents and save the freight and logistics industry hundreds of millions of dollars annually.[29] In addition, Hyundai Merchant Marine has held trials of a blockchain-based logistics system.[30]

35. Potential future applications of blockchain in shipping could include smart contracts, which are contracts in the form of a computer programme run within blockchains that automate the implementation of the terms and conditions of any agreement between parties. Several smart contract prototypes have been launched that involve digitizing electronic bills of lading and other trade documents, such as CargoDocs under essDOCS and Cargo X. However, financing, payment and insurance aspects related to shipping have not yet been fully incorporated in ongoing initiatives. Potential applications include the negotiation of freight prices directly between asset owners and their counterparts; the automatic processing of payments upon specified conditions being satisfied; and the issuance of insurance policies and settling of marine insurance claims.

b) The Internet of things

36. The Internet of things refers to the machine-to-machine connection of devices with embedded or attached connectivity and data sensing, sending, reception and analysis and or reception possibilities using the Internet. The maritime transport sector is increasingly harnessing data generated through the Internet of things to support informed decision-making related to route optimization, asset tracking and maintenance. Examples of applications include software that uses satellite-generated data to determine the most efficient route and estimate in real time the arrival time of vessels, including weather routing, which takes into account currents and weather forecasts as well as real-time sea conditions, to determine the most fuel-efficient route for long-distance voyages;[31] and emerging intelligent containers that use sensors and telematics to track temperature,

[26] UNCTAD, 2018.

[27] See presentations at www.unece.org/index.php?id=48318.

[28] Ibid.

[29] Accenture, 2018, Industry consortium successfully tests blockchain solution developed by Accenture that could revolutionize ocean shipping, 14 March.

[30] Bloomberg, 2018, Blockchain is about to revolutionize the shipping industry, 18 April.

[31] International Council on Clean Transportation, 2011.

vibration, humidity and air quality during ocean transport, such as technology used by Maersk and the Mediterranean Shipping Company for reefer monitoring.[32]

37. The Internet of things is also used to improve ship-to-shore connectivity and enable intelligent traffic management. A closer interface between ships and ports can involve, for example, the use of big data analytics to reduce transit times and time lost when entering ports and other high traffic areas, thereby contributing to alleviating port congestion. For example, a digitalization collaboration initiative between the port of Rotterdam, the Netherlands, and IBM is helping to prepare this port to host connected ships in future and involves installing sensors across 42 km of land and sea to collect information about traffic management at the port with a view to improving safety and efficiency. A similar initiative between the Maritime and Port Authority of Singapore, academic institutions in Singapore, namely the Institute of High Performance Computing and Singapore Management University, and Fujitsu aims to embed the Internet of things and artificial intelligence technologies to enable long-term traffic forecasts, hotspot calculation and intelligent coordination models.[33]

38. The Internet of things is also being used to develop systems that support navigation in challenging conditions, such as adverse weather conditions or in congested waterways. For example, in March 2018, Rolls-Royce launched an intelligent awareness system that fuses multiple sensors with intelligent software to create a three-dimensional model of nearby vessels and hazards, to increase safety.[34] Other applications of the Internet of things currently being tested include the departure of ships without human intervention, the remote controlling of the sailing of ships and the automatic docking of vessels to enable safe berthing.[35]

39. Finally, real-time records of shipping events enabled by the Internet of things provide an opportunity to optimize operations through blockchain, for example, to track spare capacity, improve connections between different legs of a journey in the global transport network and facilitate capacity-sharing.

c) Port community systems

40. Interest in port community systems is increasing, given the potential new applications and capabilities that may be generated by new digital solutions, along with their potential to serve as the basis of single windows. Port community systems have not emerged with the latest technological advances, but were initially developed in Europe to enable standardized communications platforms, to improve timeliness, reliability, costs and competitiveness. A port community system is an electronic platform that connects the various systems operated by multiple organizations forming part of a given seaport. The system links administrative and operational processes by using the same data for both. According to the International Port Community Systems Association, a port community system optimizes, manages and automates port and logistics processes through a single submission of data, connects transport and logistics chains and includes services and features related to exports, imports, trans-shipments, consolidations, hazardous cargo and maritime statistics.[36] Port community systems differ widely in terms of existing information technology infrastructure and functionality; in a paper-based and manual processes environment, a port community system could provide the foundation for a single window. Key benefits include improved business practices, increased transactional efficiency, faster processes, streamlined and coordinated activities, reduced administrative and procedural inefficiencies, lower costs and enhanced reliability (box 2). Port community systems

[32] See www.foodlogistics.com/technology/article/12236351/leading-carriers-investing-in-realtime-tracking-solutions and www.orbcomm.com/en/industries/transportation-and-distribution/cold-chain-monitoring.

[33] UNCTAD, 2018.

[34] Rolls-Royce, 2018, Rolls-Royce offers ship navigators a bird's-eye view with Intelligent Awareness game changer, 6 March.

[35] Wärtsilä, 2018, World's first autodocking installation successfully tested by Wärtsilä, 26 April.

[36] See http://ipcsa.international.

contribute to the sustainability of maritime transport and thereby support the achievement of Agenda 2030.

Box 2

Port community systems, developments in information technology and collaborative arrangements

Port Autonome de Cotonou. The Port of Cotonou uses various methods to deploy a new enterprise resource planning system and capture the perceptions and usage trends of its main users. Promoted by the Government of Benin, the new system is part of the integrated management system of the Port of Cotonou, which carries out the following tasks: vessel traffic management, stevedore operation management, invoicing, apron side and shed management, management of goods and utility, provision of supplies for ships and user resource management. This enterprise resource planning system is part of a port strategy aimed at improving port management and port efficiency, through the use of information and communications technology. User participation in the inception phase and data transfer between systems was low, and a revision and adaptation process was lacking. Furthermore, hands-on training and administrator support for users were limited. Given these factors, it was recommended that additional consultants be engaged to help improve the situation, that stronger buy-in from management and port users be obtained, that work be prioritized and that proper training be provided to improve skills.

Port of Douala, Cameroon. A case study proposed methods and procedures to increase revenue collection and better manage the port land (1,000 hectares). The port's domain revenue represents 8.4 per cent of sales revenue, while those of the ports of Dakar and Abidjan represent 18 per cent and 13 per cent, respectively. It was recommended that the cargo computer system application, which includes a domain management component, be implemented and a scheme for domain utilization and allocation be established and supervised by a dedicated commission.

Port of Dakar. Specialized installations have an important role in improving port efficiency and attracting more traffic in a highly competitive range of ports in the subregion. The Port of Dakar generates 30 per cent of State income, 90 per cent of external trade and 90 per cent of customs revenue, and caters for direct and indirect jobs in Dakar. It was recommended that the support of public–private partnerships be sought to deal with capital-intensive investments and develop transnational synergies between Senegal and landlocked countries that depend economically on the performance of the Port of Dakar. Achieving economies of scale, ensuring effective time management and enhancing land connections and global access are a must for its sustainable development.

Port of Tema, Ghana. Cargo operators were identified as an integral part of the chain of actors in the port community, and their services constitute the prime criteria in the customer satisfaction index. Cargo handling is the largest cost heading in the total costs of moving goods through a port (40 per cent for bulk, 50 per cent for containers and 60 per cent for general cargo). It was noted that investment in equipment by private stevedores was inadequate and not in conformity with the relevant licencing agreement. Ten licenced stevedores operate in competition with the Ghana Ports and Harbour Authority's own section. Data show that private operators are working with 50–65 per cent of the required equipment, which is below the 80–90 per cent rate envisaged by the agreement. This has a negative impact, including a 25 per cent delay in working container vessels, due to limited access to equipment and failure in the course of operations. Capital investments required to purchase equipment are too costly for private stevedoring companies. It was recommended that the Authority guarantee the loans.

Maldives Ports Limited. Challenges facing the Maldives Ports include limited space and infrastructure and insufficient room for rearranging the space used. Cargo is handled by ships' gears. Electronic services are one of the few options that could improve port performance. In addition, capitalizing on data modelling can help determine the best possible scenarios for cargo positioning in the port area. Expected benefits of adopting an electronic service model in Male's commercial harbour include reduced overhead costs, reduced time for the completion of procedures, minimized error rates, improved customer services, a better organizational image and increased revenues. Electronic services technology provides a unique opportunity to simplify complex working procedures and

improve port service delivery. Moreover, implementation costs are expected to be low, as most of the infrastructure and resources are already available. One challenge remains, namely, that the port community must accept the new system and opt for a comprehensive solution that does not simply combine existing single systems. Staff training would be important to combat fear of change and encourage the use of the future system.

Source: UNCTAD, 2017, *Review of Maritime Transport 2017*, United Nations publication, Sales No. E.17.II.D.10, New York and Geneva.

IV. Issues for discussion

41. Increasing the sustainability of the maritime transport sector is key to achieving the 2030 Agenda and the Goals, as well as the Paris Agreement. Examples from the Central Corridor Transit Transport Facilitation Agency and the Northern Corridor Transit and Transport Coordination Authority and small island developing States in the Caribbean show the importance of tapping the sustainability dividend of the freight transport sector. The examples underscore that achieving economic expansion need not be at the expense of social and environmental objectives and that applying a sustainability filter can be an important strategic tool in the optimal use of resources and enhancing efficiency gains.

42. Maritime transport has an important role in delivering on the global sustainability imperative. However, unsustainable maritime transport practices and related external costs need to be addressed. Mainstreaming sustainability principles into relevant maritime transport planning and investment decisions is important. Tailored and targeted policies, regulations, incentives and enabling programmes are required to promote more efficient, competitive and environmentally friendly and less energy intensive maritime transport systems. Implementing sustainable maritime transport solutions entails some cost implications and additional resources. It is therefore important to scale up investment, including through new sources and mechanisms, and promote greater private sector involvement, such as through public–private partnerships that also mainstream sustainability and resilience criteria.

43. The maritime sector is at the intersection of new developments, in particular the rise of digital technologies and innovations. Many of these technologies and technological advances have yet to become widely trusted and accepted, yet the speed at which they are evolving underscores the pressing need for the sector to prepare and embrace their potentially transformational effects. An important consideration in this regard is the potential for new technologies and innovations to help the sector to comply with the requirements of the global sustainability agenda while at the same time remaining competitive and responding to the demands of the growing world economy and trade.

44. In this context, some issues are particularly important and require further consideration and improved understanding. To consider how best to support and enable the sustainable maritime transport agenda and determine clear directions for the way forward, delegates at the sixth session of the Multi-year Expert Meeting on Transport, Trade Logistics and Trade Facilitation may wish to consider the following issues:

(a) How best can the sustainability transition of the maritime transport sector be accelerated? What is the role of industry, policymakers, investors, users, developing banks and United Nations entities, such as UNCTAD?

(b) What would be the best market-based measures that may be applied to reduce greenhouse gas emissions in maritime transport? What are the implications for transport and trade in developing countries?

(c) How can financial resources and investment be scaled up and diversified? What are the options available to maritime transport?

(d) How can maritime transport effectively reap the benefits arising from the ongoing digital revolution? How can the maritime sector and trade in developing countries benefit?

(e) How can greater standardization, coherence and harmonization in standards and methods be enhanced, for the increased interoperability of systems, in the context of the digital revolution?